



**NATIONAL EXPOSURE RESEARCH LABORATORY (NERL)  
STANDING SUBCOMMITTEE**

**Face-to-Face Meeting Summary  
U.S. Environmental Protection Agency  
National Computing Center  
Research Triangle Park, North Carolina  
December 11–12, 2007**

**TUESDAY, DECEMBER 11, 2007**

**Welcome and Opening Remarks**

*Dr. Kenneth L. Demerjian, University at Albany, Subcommittee Chair*

Dr. Kenneth Demerjian, Chair of the National Exposure Research Laboratory (NERL) Standing Subcommittee and a member of the Board of Scientific Counselors (BOSC) Executive Committee, welcomed the participants to the meeting. This is the first face-to-face meeting of the NERL Standing Subcommittee. The Subcommittee was given a preliminary introduction to the U.S. Environmental Protection Agency's (EPA) Office of Research and Development (ORD) and NERL in a 2-hour conference call held on November 28, 2007. At today's meeting, NERL staff will provide the Subcommittee members with additional background information about ORD and NERL and offer further clarification of their goals for this review.

The BOSC Executive Committee reviews research programs across ORD laboratories and centers and in the past has not offered advice and counsel to specific laboratories or centers. Several of the Center/Laboratory Directors requested that the BOSC organize standing subcommittees to evaluate the laboratories/centers and provide ongoing advice to the Directors. In response, the BOSC created two pilot standing subcommittees. The meetings of these subcommittees are structured on a series of charge questions based on the areas of interest of the particular laboratory or center.

The Chair then asked the meeting participants to introduce themselves. A list of the Subcommittee members and other participants is attached.

**BOSC DFO Remarks**

*Ms. Susan Peterson, ORD, EPA, Subcommittee DFO*

Ms. Susan Peterson, Designated Federal Officer (DFO) for the NERL Standing Subcommittee, thanked the Subcommittee members for their participation in the first face-to-face meeting of the Subcommittee. As the DFO for the Subcommittee, Ms. Peterson is responsible for ensuring that the Subcommittee complies with the Federal Advisory Committee Act (FACA).

The BOSC is a Federal Advisory Committee that provides independent, scientific peer review and advice to EPA's ORD, and as such, is subject to the rules and requirements of FACA. The NERL Standing Subcommittee has been asked to respond to a set of charge questions as part of its review of NERL. This

is the first public face-to-face meeting of the Subcommittee. A conference call was held on November 28, 2007. All meetings and conference calls involving substantive issues—whether in person, by phone, or by e-mail—that include one-half or more of the Subcommittee members must be open to the public, and a notice must be placed in the *Federal Register* at least 15 days prior to the call or meeting. As the liaison between the Subcommittee and the Agency, the DFO is required to attend all meetings. All advisory committee documents are made available to the public.

Subcommittee work time is open to the public and is subject to FACA. Subcommittee work group time is defined as a meeting of less than one-half of the Subcommittee, is not open to the public, and is not subject to FACA. All five Subcommittee members are present at this face-to-face meeting, so all meeting proceedings are open to the public and subject to FACA.

Ms. Peterson reported that no requests for public comment were submitted prior to the meeting, but the agenda allows time for public comment at 3:00 p.m. on Day 1 of the meeting. She will call for public comments at that time, and each comment should be limited to 3 minutes. Ms. Peterson stated that only comments will be accepted.

### **NERL Organization**

*Dr. Larry Reiter, NERL, ORD, EPA*

Dr. Larry Reiter thanked the Subcommittee members for agreeing to serve on the NERL Standing Subcommittee. Today's meeting is intended to familiarize the Subcommittee members with NERL and will serve as an opportunity for the Subcommittee to ask questions and provide preliminary feedback on the document entitled, "A Conceptual Framework for U.S. EPA's National Exposure Research Laboratory," hereafter referred to as the framework document.

NERL includes six research divisions, three of which focus on human exposure issues and are led by Dr. Linda Sheldon, and three of which focus on ecological exposures and are led by Dr. Rochelle Araujo. Drs. Sheldon and Araujo serve as the Associate Directors of their respective divisions. Dr. Bob Dyer leads the Research Planning and Coordination Staff. NERL is organized as a soft matrix with the division directors as the line managers responsible for implementation of the research plans. Assistant Laboratory Directors (ALDs) are similar to program managers and are responsible for the major areas of research; they work across the divisions as well as with the program and regional offices to ensure that the research NERL conducts is relevant to current priorities and responsive to the specific needs of the client offices.

In 1995, EPA underwent a major reorganization that divided ORD along the risk assessment paradigm. Fourteen laboratories were combined into three national laboratories: NERL, the National Health and Environmental Effects Research Laboratory (NHEERL), and the National Risk Management Research Laboratory (NRMRL). In the past, the research programs within NERL have tended to operate as self-contained units. The NERL leadership would like to better integrate NERL's research through the development of more cross-cutting research programs.

The Atmospheric Modeling Division (AMD), jointly managed by EPA and the National Oceanic and Atmospheric Administration (NOAA), has historically focused on air quality model development and implementation. AMD creates models at different scales, from global (climate change) to local (urban air quality assessments). After September 11, 2001, this division worked to model the dispersion of pollutants resulting from the collapse of the World Trade Center buildings. This division now is working to better link air quality models with exposure models and to ensure that the models developed are applicable to real-world policy issues. Expertise in this division includes air quality modeling, meteorology, climate change, and atmospheric chemistry/physics.

The Ecological Exposure Research Division (EERD) in Cincinnati, Ohio, historically has focused on field ecology and methods development to assess aquatic ecosystems. This division has developed indicators and provided field support for wadeable streams and, more recently, for large rivers. After the reorganization in 1995, the mission of this division was expanded to include population genetics, stream structure and function, and molecular indicators of exposure. The division's main thrust continues to be aquatic systems, with a focus on research to quantify exposures and chemical, physical, and biological stressors. EERD works to understand exposures at different levels of biological orientations, from the molecular to the community level. Much of the emphasis is on understanding broad-scale exposure signatures through understanding interactions among population dynamics, species natural history traits, and exposure profiles. Emerging research areas for this division include pharmaceuticals and personal care products as these are starting to appear in different water sources. Expertise in this division includes population genetics, molecular biology, aquatic ecology, bioinformatics, and field ecology.

The Ecosystems Research Division (ERD) in Athens, Georgia, was created in 1961 as part of the Federal Water Pollution Control Administration. It was dedicated in 1966 as the Southeast Water Laboratory and became part of EPA in 1970. In 1976, the laboratory was renamed the Environmental Research Laboratory and its mission was expanded to include ecological research. The laboratory was given its current name in 1996 when it became part of NERL. This division has become a leader in the field of environmental fate and transport, developing models at various scales and working to link fate and transport to toxicity. Currently, ERD is taking the lead in studying the fate and transport of nanomaterials and related exposure implications. Expertise in this division includes: surface and ground water modeling, site characterization, soil/sediment processes, vapor intrusion, and multimedia modeling.

The Environmental Sciences Division (ESD) in Las Vegas, Nevada, created in 1954, became part of EPA in 1970 and a division of NERL in 1995. This division plays a leadership role in many areas, including remote sensing, advanced spatial analysis, analytical chemistry, and advanced monitoring of surface and subsurface contaminants. The division has used different approaches to characterize environmental exposures of chemical and nonchemical stressors. ESD works to identify and measure stressors, describe stressor behavior, forecast the distribution of the stressors in the environment, and improve experimental designs. Expertise in this division includes landscape characterization, ecosystem diagnosis and forecasting, ecological indicators, analytical chemistry, and GIS and remote sensing.

The Human Exposure and Atmospheric Sciences Division (HEASD), located in Research Triangle Park, North Carolina, historically focused on air pollution. This division was formed as part of the 1995 ORD reorganization. Since then, the work of HEASD has expanded, in part because of new legislation. The Food Quality Protection Act (FQPA), passed in 1996, required improved exposure assessments for children. In 1997, the National Ambient Air Quality Standards (NAAQS) Act raised questions regarding the relationship of ambient particulate matter (PM) to human exposure. HEASD develops methods, measurements, and models to understand the relationships between sources of environmental pollutants, environmental concentrations, and human exposure. Current research areas include identifying air pollution sources of greatest risk, quantifying aggregate and cumulative risk, understanding risks to susceptible subpopulations, and support for air and human health regulations. Expertise in this division includes atmospheric characterization, atmospheric chemistry, source apportionment, human exposure modeling and characterization, and dose modeling.

The Microbiological and Chemical Exposure Assessment Research Division (MCEARD) historically has focused on water issues. This division originally was created in 1913 as the Ohio River Investigation Station in Cincinnati, Ohio, became part of EPA in 1970 and a division of NERL in 1995. Traditionally, MCEARD has concentrated its efforts on human exposure related to drinking water. The focus now has expanded to encompass recreational water quality and water security issues. Expertise in this division includes molecular biology, microbiology, analytical chemistry, water methods, and microbial processes.

NERL is known for its work in atmospheric science (processes and models), transport and fate (processes and models), human exposure (measurements and models), landscape characterization, measurement methods (microbial and chemical), and indicator development. Emerging areas include the use of molecular indicators or biomarkers to inform exposure assessment, microbial ecology, and systems integration (health and ecosystems).

### *Discussion*

Dr. Steve Bartell asked Dr. Reiter where the study of organisms occurs within NERL. Dr. Reiter replied that organisms are studied in the ERD in Athens, Georgia. The emphasis of that division historically has been on the fate and transport of chemicals through the environment with environmental concentrations as the endpoint. HEASD works with pharmacokinetics and issues related to ambient source distribution. Dr. Bartell asked where experimental and modeling bioaccumulation work is conducted. Dr. Reiter explained that bioaccumulation work is not performed by NERL.

Dr. Douglas Dockery said that there seemed to be a disconnect between the divisions. For example, ESD has expertise in remote sensing and GIS. How is ESD's work connected to the work of AMD? Is there a formal mechanism for tying these two divisions together? Dr. Araujo pointed out that ESD has worked closely with AMD on the statistical analysis of air quality data. They also collaborate on the mechanisms within the Community Multiscale Air Quality (CMAQ) Model, especially those related to vegetation. Dr. Dockery asked for a description of this interaction between scientists. Dr. Araujo said that, in this case, AMD is located in Research Triangle Park, and ESD also has a laboratory there, which allows for personal interaction. Dr. Reiter noted that scientists from all the divisions participate in the development of the laboratory implementation plans, which helps foster the development of cross-divisional research projects. In addition, NERL is considering creating Centers of Excellence to better connect work in certain topic areas, such as analytical chemistry. Dr. Sheldon added that NERL is working to better integrate its research. Dr. Dockery stated that work on population genetics and molecular indicators was performed in EERD in Cincinnati and metabolomics work in ERD in Athens; both are ecological divisions; these same issues are important for human exposure. Dr. Reiter commented that NERL works closely with NHEERL, which has a strong program in genomics and proteomics. The National Center for Computational Toxicology (NCCT) was established recently, and a number of senior level bioinformaticists were recently hired. In addition, cooperative agreement centers have been established at the University of North Carolina and Rutgers University. These agreements have allowed NERL to expand significantly its bioinformatics capabilities.

Dr. Michelle Frey asked how equipment is shared between laboratories. Dr. Reiter responded that the issue of equipment sharing is at the heart of the Centers of Excellence concept. Dr. Eric Weber described the new Nuclear Magnetic Resonance (NMR) Research Facility in Athens, Georgia. Users across ORD send samples to the center and then, at their own location, can tune the instrument and run experiments. Dr. Reiter added that one of the conditions of the purchase of the NMR was that it be a resource for all ORD laboratories. Dr. Frey asked if there was a need to market the equipment to other laboratories to ensure that it was used optimally. Dr. Weber said that their concern is quite the opposite; the equipment is in such high demand that it already is at a 110 percent utilization rate. It is the center's responsibility, however, to educate the remainder of ORD on how NMR can inform their research. Dr. Frey asked if there was any programmatic structure for the use of shared assets. Dr. Weber responded that ORD is currently working through that issue. Dr. Reiter explained that ORD's capital equipment fund was created to support the purchase of high-cost equipment that would otherwise be out of reach for an individual laboratory. This fund helps to bridge the gap between the laboratories and fosters collaboration. Dr. Demerjian asked if this fund is only for high-end equipment. Dr. Reiter confirmed this; the capital equipment fund is for purchases of \$75,000 or higher. Dr. Demerjian asked if the need for staff or equipment maintenance also is considered in these equipment purchases. Dr. Reiter explained that for the NMR, one of the conditions was that a staff member dedicated to the NMR be hired. In the application for

the equipment, it must be demonstrated that there also is the capability to run and maintain the equipment. Dr. Demerjian asked if that person also decides who uses the equipment. Dr. Weber said that a designated group makes those decisions. Dr. Weber reiterated that this is a new process and they continue to face challenges. Dr. Bartell asked about NERL's capital equipment costs compared to its personnel costs. Ms. Jewel Morris responded that the capital equipment costs were very small in comparison to the personnel costs. Dr. Bartell asked if EPA received funding to support its new responsibilities in the area of homeland security. Dr. Reiter confirmed that funding was allocated to support NERL's new responsibilities.

Dr. Joseph DePinto noted that the framework document emphasizes exposure to chemicals and microbiological stressors and also mentions nutrients. ERD in Athens has developed nutrient eutrophication models. NHEERL also has performed work in this area in terms of modeling and associated effects. He wondered if NERL is moving away from that work or if there will be interaction between the two laboratories on that topic. He noted that this is an important issue to address in the framework discussion. Dr. Araujo responded that the topic would be covered in the framework document discussion.

Dr. Demerjian stated that quality measurements are essential to exposure assessment. He noted that there was a group that worked on the methods development for the measurement technologies for air; he asked if that group still existed, and if so, what is its status? Dr. Sheldon responded that the group he was referring to is housed in HEASD. Its work continues despite significant budget cuts. The development of the federal reference method (FRM) has been completed, and the work now is focused on continuous monitoring methods, comparing continuous monitoring methods, and the course FRM; work also is being performed with speciated organics at ultra-trace levels and on real- or semi-real-time metals analysis. The group's primary emphasis now is on developing methods to advance source apportionment. Dr. Roy Fortmann added that because of decreasing budgets, the emphasis has shifted more to evaluation and validation of prototype new and emerging methods developed by private companies or by academia. The application of those methods to the field studies collecting data for source apportionment and human exposure research is studied. Dr. Fred Hauchman added that one of the main areas of emphasis of the MCEARD in Cincinnati, is water methods development. A significant portion of MCEARD's work is focused on developing the methods used in the occurrence studies by the regulatory program; this spans from the chemical methods to the molecular methods. Validation is not performed by the division; at that stage, the work is transferred to the program office.

Dr. Frey asked how closely NERL works with the U.S. Geological Survey (USGS). Dr. Hauchman answered that NERL works very closely with the USGS, especially in the area of emerging contaminants. Dr. Demerjian stated that there are some Small Business Innovation Research (SBIR) projects supported by the Department of Energy (DOE) studying potential analytical measurement technologies for air. He asked if NERL worked on any of those projects. Dr. Fortmann replied that NERL is not closely linked to DOE or EPA SBIR projects. Dr. Reiter mentioned that EPA's SBIR Program is managed by the National Center for Environmental Research (NCER). Dr. Sheldon said that NERL collaborates with STAR grantees and develops methods for their field monitoring. Dr. Reiter gave an example of networking across the laboratories; the perfluoro acid (i.e., PFOS and PFOA) analytical methods were developed by NERL but there was extensive collaboration with NHEERL on the associated effects work. Dr. Fortmann clarified that NERL does develop methods in cases where there are data gaps. In terms of identifying new technologies, Ms. Florence Fulk added that EERD works with NRMRL's Environmental Technology Verification (ETV) Program staff to identify new technologies; these new technologies then are tested in the field. This collaboration benefits both laboratories; NRMRL receives an evaluation of the technology and NERL can use a new technology with the potential to generate additional data.

Dr. Demerjian asked how the process of developing a new technology begins. If a client asks NERL to develop a new technology, does NERL do so? Dr. Sheldon responded in the affirmative. For example,



NERL worked closely with the Office of Air Quality Planning and Standards (OAQPS) during the development of the Multi-Year Plan (MYP) and implementation plan to prioritize the research areas. If OAQPS requests that NERL develop a new technology, that project will have to replace one on the priority list. NERL works very closely with its clients; specifically, the laboratory works to develop methods for clients' monitoring networks and to answer their research questions. Mr. Tim Watkins added that OAQPS is working with the National Air Monitoring Steering Committee. ORD hopes to soon have a permanent member on the committee. In terms of the SBIR and the STAR Programs, NERL is involved in the drafting of the Requests for Proposals (RFPs) and in the relevancy review of the proposals submitted. Dr. Reiter added that NERL also participates in the STAR Program's regularly scheduled scientist-to-scientist meetings that bring together and foster collaboration between the ORD scientists and outside scientists.

### **NERL Research Program**

*Dr. Rochelle Araujo, NERL, ORD, EPA*

Dr. Araujo stated that NERL performs research under several ORD MYPs including air quality and global change, drinking water, water quality, land, ecological research, human health, safe pesticides/safe products, and endocrine disrupting chemicals. Each topic area has a National Program Director (NPD) who coordinates the research across ORD.

NERL's Air Research Program areas include: (1) standards setting (NAAQS), including characterizing PM components/concentrations and relating concentrations to sources/exposures; and (2) standards implementation (State Implementation Plans [SIPs]), including determining the impact of atmospheric processes on air quality, enhancing methods/models for source apportionment, and providing improved air quality models. The CMAQ Model was developed by this research program and is used in conjunction with meteorology models to study priority pollutants. The Air Research Program evaluates the impact of climate change on U.S. PM concentrations, links modeling systems for air quality and climate studies, incorporates climate-air quality interaction models into decision-making tools, and performs regional case studies of air quality climate interactions in California.

NERL works to link air quality and human exposure models. The Clean Air Act requires EPA to assess human health risk to hazardous air pollutants (HAPs). Air quality standards usually are based on ambient monitoring data as a result of a lack of personal exposure data (concentration-response analyses rather than exposure-response analyses). For most pollutants, there is a lack of understanding of the relationship between ambient concentrations and personal exposures. For benzene, the CMAQ Model is used to model urban dispersion and is linked to a human exposure model to identify the relationship between ambient concentration monitoring in the urban environment and human distribution. This research has shown that exposure does not equal chemical concentration. This approach has been used in Philadelphia, Pennsylvania, and New Haven, Connecticut.

The Drinking Water Research Program works to develop methods to evaluate the currently regulated contaminants in drinking water and to address emerging issues. As the research has progressed, it has become clearer that drinking water quality and ecological processes are closely connected. ORD scientists are working to improve water quality criteria development, expand the types of water covered (e.g., recreational waters), and perform research on bioassessment/biocriteria, emerging contaminants, and headwaters/wetlands. They also are working to strengthen conditions assessment and diagnosis of sources/causes, and to improve forecasting. One example of this work is the development and validation of a same-day monitoring method for recreational water. The Beaches Environmental Assessment and Coastal Health (BEACH) Act of 2000 required EPA to develop and validate new rapid methods for monitoring recreational water. The test available at that time produced results in 24 hours, but a test that produced results in 2 to 3 hours was needed. NERL scientists developed a quantitative polymerase chain reaction (qPCR) analysis to detect an indicator of *Enterococcus* to assess water quality. This method was

compared to a gastrointestinal illness (GI) survey. It was found that enterococci concentrations correlated with swimming gastroenteritis; results from the qPCR method can be produced in 2 to 3 hours.

The range of water assessment issues is great. One example of an advance made in this area is the development of standardized protocols for large river bioassessment. Bioassessments are used by state and tribal clean water programs to evaluate ecological conditions and determine attainment of designated uses. Most streams are too large to be assessed using available methods, and method development is slowed by equipment costs, safety issues, and ecological complexity. Thus, the ecological condition of U.S. rivers largely is unknown. NERL scientists are working with state and tribal leaders to develop field methods. This work has resulted in the publication of a technical framework to guide bioassessment approaches to nonwadeable streams and rivers. In addition, the research performed by NERL has been used by a number of different organizations to support both research and programmatic applications. NERL also is working with the Office of Water (OW) to conduct a National Survey of Nonwadeable Streams for fiscal years (FY) 2008 and 2009.

Land research informs mitigation, management, and long-term stewardship of contaminated sites. NERL scientists develop sampling techniques, analytical methods, and computer models to identify, manage, and evaluate contaminated sites. Land research also supports the management of material streams and conservation. Tools have been developed to characterize and minimize waste streams, model fate and transport, and inform risk assessments. One of the major issues is the need for a national scale assessment for reducing priority chemicals. The reduction in risk to human and ecological receptors resulting from the reduction of certain waste streams containing Waste Minimization Priority Chemicals (WMPC) needed to be quantified. To do this, 419 waste sites were identified as representative of the nation, and NERL scientists were able to assess the reduction in chemicals needed to protect the land. This research has been used by EPA's OW, the Office of Management and Budget (OMB), and community stakeholders; it also was used to establish a performance metric for the Resource Conservation Change (RCC) Program. This research enables scientists to quantify risk reduction on a national scale and assess the benefit of waste reduction programs; it can be used retrospectively or in future scenarios.

With pesticides, the aim is to minimize harm while maximizing benefits. NERL exposure research works to identify "omics" and chemical-based markers of exposure, uses molecular methods for assessing pest resistance to plant-incorporated pesticides (PIPs), and develops methods and models for characterizing exposures to high-priority pollutants. Transport and fate work has included the development of a model to map pesticides from source waters through drinking water systems to consumers as well as the development of a pesticide fate model for pesticide registration. For example, EPA needed a reliable predictive model to establish the likely exposures, risks for nontarget organisms, and ecological systems. Three regulatory predictive models (AgDRIFT, PRZM, and EXAMS) were combined to analyze pesticide exposure. The information generated reduces the uncertainty in risk assessment and provides data to support pesticide registration.

The Human Health Research Program assesses aggregate exposures and cumulative risk through the use of probabilistic models for estimating exposures/doses, exposure reconstruction from dose to source, and field studies to characterize real-world exposures and key factors influencing exposures. For vulnerable populations, factors influencing exposure are identified; models are evaluated for their ability to assess exposure; and tools are developed to identify vulnerable communities, identify key sources, and demonstrate the effectiveness of risk mitigation strategies. One example is the work performed by NERL scientists to identify factors influencing children's exposures to pesticides. In this case, there were insufficient data to assess adequately multimedia exposure to environmental contaminants such as pesticides. Routes through which children are exposed to pesticides were studied and it was determined that the dominant pathways for intake were via skin and direct ingestion. This work has helped to replace assumptions with real-world data; the results will be used to support the development of prevention strategies for children and caregivers. In addition, this research can be applied to the study of children's

exposure to other chemicals. Another example of research in this area grew out of a concern about children's exposure to the wood preservative chromated copper arsenate (CCA) on treated playsets and decks. The concern was that children potentially were being exposed to arsenic (As) and chromium (Cr) residues and that these residues leached into the surrounding soil. A probabilistic exposure and dose assessment was performed on the As and Cr components of CCA using the Stochastic Human Exposure and Dose Simulation Model for Wood Preservatives (SHEDS-Wood). This predicted the central values for lifetime annual average daily dose; it was determined that, in most cases, residue ingestion via hand-to-mouth contact was the most significant exposure route. This work has supported EPA decisions on CCA-treated products and is used to inform risk management and re-registration eligibility decisions for CCA and support public messages about minimizing health risks from existing treated wood structures.

Ecosystems protection research characterizes stressors at the landscape scale, uses air quality models for ecosystem stressors, identifies stressors to ecosystems, and forecasts changes in ecosystems with changes in stressors. NERL scientists also are working to advance the science of bioassessment. One example is incorporating "DNA barcodes" into assessment protocols, which has been done for invasive species in the Great Lakes and Pacific Northwest and for EPT taxa in Maryland. This approach has increased the precision and scientific objectivity of stream bioassessments. One of the major challenges for the ecosystems program is addressing stressors that impact ecosystems over a range of scales, from climate change to specific pollutant issues. NERL scientists are working to develop tools and methods to integrate multiple, concurrent impacts and to evaluate alternate approaches. In North Carolina, the Charlotte area is developing rapidly. The Regional Vulnerability Assessment Sustainable Environment for Quality of Life (ReVA-SEQL) Model is used along with existing data to evaluate vulnerabilities, forecast consequences, and evaluate options. Another approach to forecasting has been taken to determine alternate futures for the diverse San Pedro Basin area. Multiple data layers were used to characterize the area. The Automated Geospatial Watershed Assessment Tool was used to determine potential outcomes, given different levels of development.

## ***Discussion***

Dr. Frey asked if NERL is responsible for the *Report on the Environment*. Dr. Araujo replied that the *Report on the Environment* is prepared by the National Center for Environmental Assessment (NCEA). Data from NERL are used to support the grading. Dr. Frey asked about the sources of the data that are used to inform that report. Dr. Araujo replied that much of the information comes from the Office of Environmental Information (OEI). Other data comes from ORD's laboratories and centers. Dr. Sheldon added that the *Report on the Environment* is used in the Human Health Research Program to link sources to human health outcomes.

Dr. DePinto pointed out that NERL has developed a number of models to assess exposure from different areas; there also are a number of models that forecast climate change and a range of outcomes. Has a strategy been developed to determine how climate change will impact exposure? Dr. Araujo replied that some of NERL's work addresses exposure issues related to climate change. EPA is responsible for conducting climate change assessments that correspond to its regulatory mandates; there is a Climate Change Program within ORD. EPA currently is examining the possibility of using ecosystem services to compare and contrast changes. Dr. Reiter added that the Climate Change Program produced a draft report on global air quality that used NERL's air quality model and compared the results from the NERL model with those generated by other models, including those from Harvard and the University of Michigan. Discussions are underway to determine why different results were produced by the different models.

Dr. Demerjian asked if data are available to demonstrate the effectiveness of regulations in improving the health of ecosystems. Dr. Araujo responded that, with ecosystems, definitive statements cannot be made because there has never been an unbiased sampling. OW especially has faced this challenge in terms of the need to locate impairments, determine the cause, and report on the overall state and condition in an



unbiased way. Historically, OW monitoring systems have been more focused on identifying locations and causes of impairment. Dr. Demerjian asked if Dr. Araujo thought that the public could be convinced of the importance of ecosystem services by focusing on the fact that everyone benefits from such services. Dr. Araujo replied that this continues to be a challenge; the ecosystem services field is working to identify the specific benefits of ecosystem services. The challenge is twofold: (1) how to capture the benefits of a healthy ecosystem, and (2) how to make the public care about ecosystems.

Dr. Demerjian asked if the framework document addressed these issues. Dr. Araujo replied that ecosystem condition indicators can be and are used to inform assessments. Using existing data to demonstrate the importance of ecosystem services to the public is very important. Dr. Frey asked if a document describing all of the available data existed. Dr. Araujo replied that she did not know of such a document; to her knowledge, the data are scattered and the challenge is to bring them all together.

Dr. Bartell asked how NERL maintains a balance between core research and applied research. Dr. Araujo replied that this always is an issue within the laboratory. NERL aims to have a balanced portfolio, but in reality NERL's portfolio is closer to 60 percent problem-based research and 40 percent core research. NERL is committed to conducting fundamental research and works proactively with program offices to identify future core research needs. Dr. Reiter added that the National Research Council (NRC) report has played an important role in helping NERL to keep its ratio steady, because there is always a tendency to address short-term issues. Core research is important because it addresses major gaps and scientific uncertainties that affect the Agency's ability to make informed decisions.

### **Exposure Science Framework**

*Dr. Linda Sheldon, NERL, ORD, EPA*

Dr. Sheldon stated that NERL has a long history of conducting cutting-edge exposure research that provides scientific knowledge for EPA policy decisions; NERL also plays a scientific leadership role in exposure research. Until recently, however, there was no thread connecting NERL's research. The framework document was developed to create an identity for NERL, help NERL connect its research, and develop a common understanding and common language for NERL. The framework document defines exposure research, details the use of exposure research at EPA, and includes concepts and designs for implementation of the research plan within NERL. The document is intended to guide strategic planning and organization, be used as a marketing tool to help others better understand exposure research, and communicate NERL's purpose and mission, both internally and externally. The framework document includes four sections: (1) Introduction, (2) Exposure Research, (3) Exposure Research at EPA, and (4) NERL's Exposure Research Program (for internal purposes only).

Section 2 (Exposure Research) covers exposure science, defining exposure as the contact of a stressor with a receptor. The exposure is described by the intensity, frequency, and duration of the contact. A stressor is defined as a chemical, biological, or physical agent with the ability to lead to an adverse impact. A receptor is defined as a living organism or group of organisms. In human health, the receptor is an individual or a population of individuals. In ecology, the receptor is an individual plant or animal, a community, or an entire ecosystem. Populations and ecosystems at greatest risk must be protected; thus, it is essential to identify and understand the intersection of the biggest stressors and the most susceptible subpopulations. Vulnerability (exposure/activity) factors include age or life stage, culture and lifestyle, activities and occupation, geographic locations/distributions, and socioeconomic status. Biological susceptibility factors include age or life stage, gender, genetic differences, prior status, and previous exposures. The Exposure Research section identifies and characterizes stressors and receptors; it characterizes and links processes for propagation and fate from sources through the environment, contact of the stressor with the receptor, and uptake/impact on the receptor (dose or equivalent).

The Framework builds on similarities between human health and ecological research, but there are some important differences:

#### Human Health

- ✍ Protection from environmental stressors only
- ✍ Chemical and microbial stressors
- ✍ Single receptor—human
- ✍ Receptor is the same across all locations
- ✍ Traditionally risks are evaluated one stressor at a time
- ✍ Exposures and outcomes end with the human receptor

#### Ecological

- ✍ Protection of the health of an entire ecosystem
- ✍ Physical conditions are primary
- ✍ Multiple receptors
- ✍ Location determines the receptor
- ✍ Risks are evaluated for multiple stressors using a systems approach
- ✍ Exposure and outcomes cascade (the outcome for one receptor may be a stressor for another)

Exposure is complex. Aggregate exposure includes exposure from all sources, routes, and pathways. Cumulative risk includes risks to exposure over time and to multiple stressors. Exposure is a fundamental aspect of ecological research but is a new concept for human health research.

Because it is impossible to measure everything at all times, models are fundamental parts of an exposure research program. Models are used to inform the exposure assessment process (distributions, uncertainty, and variability), assess compliance and summarize available knowledge, and evaluate alternative regulations. Models also offer a framework for assessing compliance. The importance of models will continue to increase as computational methods advance. For example, the CMAQ Model is used daily to forecast air quality. Measurement research provides a fundamental understanding of the processes described in models; methods research provides the measurement tools for research and for regulatory monitoring.

Environmental protection must address the entire source-to-outcome continuum. Multidisciplinary research across disciplines is needed. Health scientists, engineers, risk assessors, and decision-makers must all work together. NERL is working to identify collaboration opportunities and better support collaboration.

EPA's mission is to safeguard public health and the environment. Exposure information can provide the critical link between source/regulatory monitoring and outcomes and can substantially improve our understanding of environmental protection in the future. Dr. Sheldon presented a graphic of the source-to-outcome continuum. The three key questions that EPA needs to be able to answer are: Is mitigation necessary? What is the best way to mitigate? Was mitigation successful?

Dr. Sheldon presented a list of enabling legislation which included: the Clean Water Act; the Safe Drinking Water Act; the Clean Air Act; the Toxic Substances Control Act; the Federal Insecticide, Fungicide, and Rodenticide Act; the Endangered Species Act; the FQPA; and the Federal Food, Drug, and Cosmetic Act.

Historically, explicit use of exposure research was minimal because of severe and immediate needs. Ambient concentrations were used for exposure in risk assessments such as the NAAQS and Drinking Water Standards. This approach works well when the standard is not risk-based; the exposure level is much higher or lower than the risk level; there is only one source and pathway and relationships are well understood; and environmental concentrations are homogeneous.

Today's challenges require better exposure estimates. Exposures come from multiple pathways and routes and can come from multiple stressors, resulting in cumulative risks. Stressors often have significant

spatial and temporal variability. Examples include fine particulate sulfate versus coarse PM in air and chemical contaminants versus microbes in drinking water.

### ***Discussion***

Dr. DePinto asked about the audience of the framework document. Dr. Sheldon replied that the primary audience is NERL. The framework document gives NERL a new perspective, focusing more on partnering and collaboration, within NERL and with the other EPA laboratories and centers. Dr. Reiter said that he also sees the exposure science community as an important audience for the document. Many scientists are conducting high-quality research, but there is nothing connecting their work. The exposure framework document also will help others within EPA to understand how exposure research can answer some of the questions that the Agency must address.

Dr. Dockery, an epidemiologist, said that his work with exposure researchers has been essential to producing quality research. He asked if NERL works with health effects researchers. Dr. Sheldon replied that NERL does work closely with health effects researchers. For example, CMAQ is used to forecast daily air quality, an important component of air pollution epidemiology. NERL collaborates with Harvard faculty on gene-environment work, with Duke University faculty on birth outcomes, and with researchers for the National Children's Study to develop models on the community level. Dr. Reiter added that NERL is working to better link its models to health outcomes and to strengthen exposure assessment in community-based health studies. Collaboration is a major area of emphasis for NERL. Dr. Reiter suggested strengthening the collaboration text in the framework document.

Dr. Demerjian stated that EPA does not currently include indoor air as part of its mission. Does any of NERL's research address indoor air? Dr. Sheldon replied that some of the research presented by Dr. Araujo included both indoor and outdoor air. In fact, many of NERL's models can be used to address both indoor and outdoor air. Dr. Demerjian asked if Dr. Sheldon thought that there were enough data to characterize indoor air for different locations. Dr. Sheldon replied that NERL has indoor and outdoor air data from a number of its studies; the Detroit Exposure Aerosol Research Study measured infiltration and models were developed to separate outdoor contributions from the indoor contributions. NERL also has a very strong program measuring pesticide concentrations indoors. Dr. Fortmann added that NERL studies other chemicals indoors, such as flame retardants and perfluorinated chemicals. NRMRL continues to perform research on indoor sources as well; some of NRMRL's data are available for modeling purposes. Dr. Hauchman added that NERL works with the U.S. Department of Housing and Urban Development (HUD) to identify field applications for methodologies developed by NERL.

Dr. Bartell said that it seemed as though there was no entity responsible for pulling all of the disparate information together. He thought that this issue might be beyond the scope of the current discussion, but it is an important one. Dr. Sheldon responded that she thought that OEI was responsible for pulling together that information. A question often asked within NERL is: What is research and what is simply pulling information together? NERL is a research laboratory, so its efforts must focus on conducting research. Dr. Weber clarified that NERL focuses its efforts on exposure modeling science. NERL's models can be used to generate data, but the program offices have been reluctant to embrace this approach. Dr. Demerjian said that there must be a statistical design to demonstrate that the calculations are successful in predicting the measurements. He pointed out that exposure science must address issues on many different scales. For example, air quality must be addressed from a global to a microscale level. He was on the task force to restructure ORD; the current structure is very close to the task force's recommendation. The idea was that the common thread between all the laboratories would be process science. He asked if exposure science is truly a science. It is not like the chemical, physical, or biological sciences; it is an applied field, but it is clear that to support this field, a fundamental understanding of processes and measurement methodologies is necessary. He wondered if the laboratory should be defined by something broader than exposure. Dr. Reiter said that he had supported a different model with a more explicit connection between exposure and outcome. He later came to realize, however, that the

organization is not as important as he had thought because there always will be a need for collaboration and interaction across organizational boundaries. He said that he would like to stay on course and determine how to make the current structure work more effectively.

Dr. Bartell asked if NERL's responsibility stops at exposure. Dr. Reiter responded that NERL research is intended to inform the exposure assessment. NHEERL works on the dose-response side, and NCEA or the program office combines the information to develop the risk characterization. Exposure plays a pivotal role in all of these activities.

Dr. Demerjian asked if NERL was working to identify health or ecosystems outcomes related to air quality. Dr. Sheldon responded that NERL is collecting data to better understand the various processes that control fate and transport in different areas of the country. In terms of human health, Dr. Dockery said that he believed that it was most often location that determined exposure (i.e., where a person lives). With all of the data available on different scales, from satellite data to ambient monitoring data, there is a tremendous opportunity to pull it all together. For example, the data could be used to create a tool that would allow the user to enter his/her location and obtain all of the environmental information about that specific location. Dr. Sheldon added that she envisioned something similar to the CMAQ exposure maps. Dr. Araujo said that one of the strengths on the ecosystems side is that exposure plays a part in virtually every problem. She added that the drafting of the framework document already has promoted collaboration; NERL is hoping there will be even more collaboration as the framework document is applied to NERL's work. Dr. Dockery said that he sees great opportunity in applying a systems approach similar to the ecological systems approach to human health. He asked if the source apportionment work being performed by NERL is primarily driven by the health community. Dr. Frey asked for a definition of source apportionment. Dr. Sheldon replied that source apportionment involves determining the primary sources that are causing pollution. For example, determining the primary causes of air pollution in an air shed involves using measurements from the site and a CMAQ Model to determine the most likely sources of the pollution.

Dr. Frey said that she thought that the human health diagram in the framework document was too simplistic. Human health issues are very complex, especially in terms of disease propagation. Hospital infections are one example of a cascade effect. Drs. Sheldon and Araujo agreed.

Dr. Demerjian asked if NERL has the ability to discontinue work that it has determined, possibly because of existing regulations, will have virtually no impact. Dr. Araujo said that it is NERL's responsibility to develop tools to help others see the complex set of interactions to inform their decisions to meet both regulatory and nonregulatory endpoints.

Dr. DePinto stated that he liked Figure 3.1 in the framework document because it captures the central importance of exposure; he is concerned, however, that starting with the stressor implies that the stressor has direct contact with the receptor. In reality, a stressor is much more than simply the element that has direct contact with the receptor. He said that he did not see consistency between the definition of stressor at the beginning of the framework document and the implicit definition of stressor at the end. He is concerned that this may confuse the general public. In his view, the most critical part of exposure assessment is understanding everything that happens to a chemical and the ultimate contact with the receptor. Dr. Sheldon responded that they would revisit Figure 3.1 to make sure that it is clear. Dr. Reiter asked Dr. DePinto for further clarification. Dr. DePinto posed the question: Which would be considered a stressor, the chemical coming out of a pipe or the chemical after it has traveled through the environment and reached the receptor? Dr. Sheldon responded that either one could be the stressor. Dr. DePinto said that he did not think that the framework document placed enough emphasis on the processes that occur between the release of a chemical into the environment and the actual uptake or contact with the receptor. Dr. Frey added that the process of the exposure must be modeled. Dr. Araujo said that in drafting the framework document, they tried to keep the language general to cover all the bases; however, they are

open to suggestions on better defining stressors. Dr. DePinto suggested adding text on the distinction between direct and indirect stressors.

### **Framework Implications for NERL**

*Dr. Linda Sheldon, NERL, ORD, EPA*

Dr. Sheldon reiterated that NERL's organizational goals are to conduct cutting-edge exposure research that provides scientific knowledge for EPA policy decisions and to provide scientific leadership in exposure research. Section 4 (NERL's Exposure Research Program) of the framework document defines NERL's research and discusses the implementation of NERL's research agenda and the communication of research results to the public. NERL's research portfolio addresses critical science issues on topics such as water, air, land, human health, and ecological research. The research aligns with the MYPs, but it also is dynamic. Often, new areas must be evaluated to determine if exposure research is needed. Examples of new areas include homeland security, computational toxicology, and nanotechnology. New areas are evaluated based on the following questions:

- ✍ Does the research support the Agency's mission?
- ✍ Is it exposure research?
- ✍ The proposed research should meet one or more of the following criteria:
  - ? Does it require NERL's expertise or unique facilities?
  - ? Is it a priority research area?
  - ? Does it require an integrated approach that only NERL can provide?
  - ? Are exposure and exposure data an integral part of the overall research question?
  - ? Is it the right time for NERL's involvement?
  - ? Does the scope and scale of the research require NERL's involvement?

After a decision is made to conduct research in a specific area, an integrated, multidisciplinary research program that will provide critical scientific knowledge for EPA's actions is developed. Priorities and the critical paths to achieve those priorities are identified. In addition, specific products and outcomes are identified. NERL's research is a combination of core and problem-driven research. Core research includes investigations to elucidate key processes that underlie environmental systems, thus providing the basis for responding to a wide range of environmental problems. Problem-driven research includes investigations that attempt to understand and solve an identified problem. NERL works to balance the two areas, working with program offices to address their needs but also keeping a long-term research perspective in mind.

Dr. Sheldon presented a graphic depicting the steps in developing a research program. The guiding questions are:

- ✍ What is the problem facing the Agency?
- ✍ What are the key science questions underlying the problem?
- ✍ What are the approaches to answer the key scientific questions?
- ✍ What research products will be produced (annual performance measures)?
- ✍ How will the research products support Agency strategic products and decisions?

Dr. Frey asked Dr. Sheldon to explain the research prioritization process. Dr. Sheldon said that prioritization occurs during the development of the research program implementation plan. After the research begins, there can be further prioritization to refine the program's work. Dr. Reiter added that each topic area develops an MYP that is mostly shaped by the regulatory requirements in that area; in



most cases, the available resources are not adequate to address all the priorities detailed in the MYP, so further refinement of the research emphasis is necessary.

Broad questions are asked to identify EPA's role in an emerging issue:

- ✍ Should EPA take an action? For example, does exposure to PM<sub>2.5</sub> in ambient air cause death and hospitalizations?
- ✍ What actions should EPA take? For example, how does EPA regulate the introduction of invasive species through ballast water discharge?
- ✍ Have EPA's actions made a difference? For example, has the recent mercury rule resulted in a decrease in the levels of mercury in the environment?

The main driver for the development of a research program must be the key exposure research questions underlying the Agency problem.

*Should EPA take an action?*

This most fundamental question asks if exposure to a stressor leads to a human health or ecosystem risk. This leads to a hierarchy of general exposure questions including:

- ✍ How is the exposure assessment currently performed?
- ✍ Is this adequate?
- ✍ What are the limitations?

More specific questions include:

- ✍ What are the levels of the stressor in the environment?
- ✍ What is the extent of exposure to the stressor for humans and ecosystems?
- ✍ Are the exposure concentrations higher or lower than the risk level for the contaminant?
- ✍ Is the level of uncertainty of the exposure estimates acceptable?
- ✍ Is the risk of exposure to the contaminant of concern enhanced or mitigated by the presence of other stressors or physical parameters (i.e., Is there a need for a cumulative risk assessment?)?

*What actions should EPA take?*

After it is determined that EPA should take action, the next step is to identify the best way to reduce exposure or demonstrate compliance. Specific questions include:

- ✍ What are the major routes, pathways, and sources of exposure?
- ✍ What is the relationship between source, environmental concentration, and exposure?
- ✍ What factors impact these relationships?
- ✍ How can exposure to a stressor be reduced?
- ✍ What are the tools (models and methods) and data needed to identify effective risk management procedures? What are the critical limitations to these tools?
- ✍ How should compliance be determined? Where, what, and how will compliance monitoring be measured?
- ✍ Are there nonregulatory policies and/or public information that could be used to mitigate exposures?

*Have EPA's actions made a difference?*

Key questions include:

- ✍ How can EPA measure the impact of environmental policies on the health of humans and ecosystems?

- ✍ What are the exposure data and indicators that can be used to address effectiveness?
- ✍ Are exposure indicators available that are sensitive and specific for the stressor of concern?

Prioritization should be supported by quantitative data, if possible. This helps to quantify the importance of the information to be produced. Using the data, models for exposure are developed (these can be conceptual models) and research questions are developed based on the model. Current knowledge and current research projects are identified to determine if additional research is needed. The potential impact of the research also is evaluated.

NERL is known for its work in processes and models for the atmospheric sciences (e.g., CMAQ, source apportionment) and for fate and transport; human exposure measurements and models; landscape characterization; microbial and chemical measurement methods; and indicator development. Emerging areas include chemical and microbial molecular indicators, microbial ecology, and systems integration for human health and ecosystems, including framework development, model linkages, and informatics. Dr. Demerjian asked why nanotechnology was not on the list. Dr. Sheldon agreed that nanotechnology is an emerging issue; the challenge is applying nanotechnology in all of these areas.

NERL's management goals include achieving its mission of conducting high quality research that addresses EPA problems, creating better solutions, ensuring efficiency of research and resources, leveraging resources and expertise, and providing a stable environment for conducting and completing research. NERL serves EPA by researching exposure, following these management principles:

- ✍ Science comes first.
- ✍ Multidisciplinary approaches are used where appropriate.
- ✍ Functional solutions are sought first.
- ✍ Use of existing resources is optimized.

For each MYP, the six centers and laboratories work together to develop an implementation plan (IP). Looking across the implementation plans, research needs then are prioritized based on factors such as client needs, impact, novel contribution, and balance between problem-driven and core research. Resources are allocated to the highest priority areas first. Resources, however, also must be balanced across the MYPs and across the divisions. Understanding priorities and resources enables NERL to ensure sufficient resources are available to successfully complete the most relevant work, make informed decisions about redirecting resources, and direct workforce planning.

NERL is working to increase collaboration. Potential new structures under consideration include Centers of Excellence and virtual research teams; it will need to be determined how best to organize and manage these new structures. Dr. Sheldon added that NERL also is working to better communicate the results of its research; it is essential that NERL's research results be communicated to all who can use the information.

## ***Discussion***

Dr. Frey asked if NERL management positions are filled by research scientists or by people from outside EPA. Dr. Reiter replied that it depends on the situation; in some cases, scientists are promoted from within and, in other cases, outsiders are brought in. This is probably one of the biggest organizational challenges that NERL faces. NERL has a very low turnover rate, but the skill base needs change from time to time. As budgets have decreased, the focus has shifted toward intramural research. In the past, there was an intramural scientist for every full-time equivalent (FTE) and any associated work was performed through a contract and/or through the funding of extramural research. This has changed. NERL's research base now consists mostly of scientists who are principal investigators (PIs).

Strategically, NERL is trying to narrow its breadth and build up its depth so that the technical support is available for the scientists conducting the research. NERL leaders are in the process of succession planning; the goal is to provide NERL employees with the appropriate exposure experience so that the laboratory will not have to rely on outside recruiting.

Dr. Demerjian asked how it is determined that a Center of Excellence is needed. Dr. Sheldon said that NERL employees from four different divisions work in analytical chemistry, so it makes logical sense to coordinate the work of those employees through a Center of Excellence. Dr. Reiter added that NHEERL initiated the Center of Excellence concept and has hired an employee to manage the development of these centers. Ms. Fulk said that they are exploring the possibility of creating a Genomics Center of Excellence in Cincinnati. There are a number of different organizations working in genomics and EERD currently is undergoing a renovation, which provides an opportunity for reorganization.

Dr. Frey asked if an infrastructure exists to support things like information management or database management. Dr. Reiter replied that funds are set aside for infrastructure support; the laboratories and centers submit proposals, and the resources are allocated accordingly.

Dr. Bartell said that it seemed that there were scale incompatibilities between the MYPs and the implementation plans; it would be difficult for PIs to conduct their research if there was always the possibility that the research emphasis might change. Dr. Reiter responded that both the MYPs and the implementation plans are developed from a long-term perspective. In fact, the reality is that researchers become entrenched in certain areas; when a new area emerges researchers tend to try to frame their current work as applicable to the new area. Dr. Weber added that the PIs are involved in the development of the implementation plans. Dr. DePinto asked if the research emphasis is determined by the decision-makers. If so, do the scientists then work with the decision makers to achieve the stated goals? Dr. Reiter replied that the implementation plan goes through many drafts, with the first draft often reflecting the status quo. The scientists then are encouraged to consider how they will apply their expertise to the new problem or issue. Then, there are discussions to further refine the implementation plan. If resources are not available, the scientists make suggestions and work with the decision-makers to determine how best to address the problem with the resources available.

Dr. Bartell asked if NERL offers tangible rewards for collaborative research. Dr. Reiter replied that collaboration is considered in the promotion process. In addition, a teamwork award is given each year to recognize collaborative work. Dr. Sheldon added that working on high-priority issues promotes collaboration through the high profile nature of the work and through the allocation of resources. Dr. Hauchman commented that NERL is more supportive of collaboration than some of the other centers and laboratories. Dr. Bartell asked if the framework document was meant to influence the other centers and laboratories to better support collaboration. Dr. Hauchman responded that he did not know.

Dr. Demerjian asked if there was a hierarchy in the prioritization process. In other words, are client needs at the top followed by ORD long-term commitments, and so forth? How does prioritization occur? Dr. Reiter replied that in the problem-driven areas, the program office/regional priorities are the main driver. For the core research, the prioritization depends on many factors, including the answers to questions such as:

- ✍ What is the nature of the problem?
- ✍ Is there an exposure component?
- ✍ Is it high risk?
- ✍ Are there large uncertainties?
- ✍ Can NERL's research make a difference?
- ✍ Does NERL have the expertise needed?

NERL is trying to place more emphasis on the areas of research where its work will have the greatest impact. Dr. Sheldon added that the needs of the program offices also are considered in the planning of core research.

Dr. Frey drew a diagram representing uncertainty in terms of exposure and human health and research priorities; she suggested that NERL use a diagram or something similar to map the value added by individual research projects. Dr. Frey said that she did not see anything in the framework document to represent this first level of prioritization. Dr. Sheldon replied that this occurred during the conceptual model building. At this phase, it is determined what is currently known, what is not known, and the potential impact of additional information. Dr. Frey suggested that NERL develop a common algorithm that will be used for prioritization to give the scientists a better understanding of how decisions are made. Otherwise, the researchers will not know where to focus their energies.

### **Public Comment**

*Ms. Susan Peterson, ORD, EPA, Subcommittee DFO*

Ms. Peterson called for public comments at 3:00 p.m. There were no public comments offered.

### ***Discussion (continued)***

Dr. Demerjian asked whether NERL decides the emerging areas on which to focus or if that decision is made at a higher level in the Agency. He asked specifically about NERL's work in nanotechnology. Dr. Reiter responded that in FY 2007 ORD allocated about \$4 million to begin a nanotechnology program. Most of those resources were allocated to NERL to study issues of transport, fate, and exposure. Dr. Demerjian asked if NERL intended to use the framework to guide how money allocated for research in new areas is spent. Dr. Reiter said that in the case of nanotechnology, the framework was still in development, but it was used with the implementation plans to guide the development of the research. Dr. Bartell asked for a more detailed description of the process. Dr. Reiter responded that a steering committee is established at the ORD level. This committee includes representatives from across the laboratories and centers, the appropriate division directors, and scientists. He added that, under the core research programs, researchers have the opportunity to conduct exploratory research.

### **Subcommittee Follow-Up Questions**

*Dr. Kenneth L. Demerjian, Subcommittee Chair*

Dr. Demerjian asked Dr. Reiter which group most needs to understand the framework document. Dr. Reiter replied that because the framework document will be used to guide NERL as an organization, it is crucial that NERL employees understand the document. Dr. Reiter pointed out that Ms. Valerie Garcia had used the framework document in the development of an implementation plan. Dr. DePinto asked if the division directors thought the document was a useful tool for guiding their research planning. Ms. Garcia, a Deputy Director in the Atmospheric Modeling Division, stated that the framework document had helped her to focus on exposure research and identify potential areas of collaboration during the development of an implementation plan. Dr. Frey asked Ms. Garcia which she found to be most important, the term "research" or the term "exposure." Ms. Garcia replied that the research often is determined by the program offices, so she focused more on defining exposure. Ms. Fulk, from EERD, said that the framework document defines exposure research and illustrates where exposure research fits into the big picture. Many PIs in EERD have welcomed the document, as it has helped them to better focus their work. Dr. Fortmann, from HEASD, added that the document provides NERL employees with a common understanding of the principles and processes under which NERL operates. Dr. Hauchman, from MCEARD, stated that most of the work in his division is mandated by the Safe Drinking Water and Clean Drinking Water Acts. MCEARD employees already have a good understanding of their role, but

the framework document helps the division's scientists keep their research focused on exposure. Additionally, the document will help new researchers understand NERL and its place within EPA. Mr. Heggem, from ESD, said that his laboratory is going through a major transition because of the recent decrease in extramural funding; the framework document will help his division identify its niche. Dr. Demerjian asked if the exposure framework includes all of NERL's work or if the document is intended to offer an integrated structure for NERL. Would the document explain NERL's work to an OMB representative? Dr. Reiter said that if he needed to explain NERL's work to an OMB representative, he would use the framework document as an introduction and then describe some of the specific research conducted by NERL.

Dr. Dockery mentioned that the National Institute of Environmental Health Sciences (NIEHS) had articulated another vision of exposure as part of their Genes, Environment, and Health Initiative. Dr. Reiter responded that the innovations in measurement technology that will result from that initiative will be extremely useful. The Exposure Biology Program, however, focuses on measurement technologies and on understanding biomarkers as they relate to outcome, not as they relate to exposure. NERL's work is focused on exposure. NERL currently is in discussions with the Centers for Disease Control and Prevention (CDC) to add questions to the National Health and Nutrition Examination Survey (NHANES) to better inform exposure assessment. Dr. Demerjian asked if NIEHS initiative would address health outcomes. Dr. Reiter replied that, for exposure assessment, the biomarker measure is not sufficient, but NIEHS is working to identify some disease outcomes for which there is strong evidence that those biomarkers are related to environmental exposures. The emphasis is on moving from outcome to exposure, but there seems to be no inclusion of pathways, routes, or sources, all of which are critical issues for an exposure assessment. Dr. Sheldon said that there is some overlap between the work of NIEHS and NERL. NIEHS currently funds research to develop prototypes based on work originally funded by NERL. Dr. Demerjian asked if NERL had considered using NHANES data to ground truth its exposure models. Dr. Reiter said that discussions with CDC are just beginning, but one of the topics that has been discussed is the companion data that NERL needs to better inform its models.

The group discussed adding some missing environmental regulations and statutes to a list in the framework document. Dr. Reiter explained that the list was a work in progress. He added that NERL is meeting with program office representatives in January to discuss how they do or do not apply exposure research in their regulatory decisions and to better identify their needs. Dr. Demerjian said that he knew of two NHEERL studies on air quality and health outcomes; he asked if NERL provided the source apportionment data for those studies. Dr. Sheldon said that NERL regularly provides source apportionment data to NHEERL. Dr. Demerjian asked if NERL had experienced any difficulties in working with NHEERL. Dr. Sheldon said that NERL sometimes ran into difficulties; in one instance, NERL hired a postdoctoral fellow who was able to bridge the gap between the two laboratories. Dr. Reiter added that there is a cultural shift toward collaboration occurring across ORD. From his perspective, the collaboration between NERL and NHEERL is better than it has ever been and continues to grow stronger.

Dr. Demerjian asked whether the other ORD laboratories and centers had reviewed the framework document. Dr. Reiter said that they had not. NERL wanted to incorporate the Subcommittee's feedback before distributing the document within NERL; then, distribute it to the other ORD laboratories and centers. Dr. Frey asked the NERL leadership to rate the importance of the different audiences for the framework document on a scale of 1 to 5, with 5 being most important. Dr. Reiter gave ratings ranging from 2.5 to 3.5 for the different audiences (ORD = 3.5; EPA program offices and managers = 3.5; other federal agencies = 2.5; external partners = 3). Dr. Sheldon said that she would give a rating of at least 3 for all of the audiences mentioned and for the general public. Dr. Reiter said that he thought the document would have equal value outside of NERL, but the greatest value would be within NERL. Dr. Weber asked if the Subcommittee members had any suggestions for an appropriate place to publish the document in the



peer-reviewed literature. Dr. Demerjian suggested that the text be edited to be less Agency-specific before it is submitted for publication. He proposed that NERL consider submitted it to *Environmental Science & Technology* or the *Journal of the American Water Works Association*.

Dr. Reiter asked the Subcommittee members if they thought the framework document would help move NERL in the right direction. Is there anything missing? Dr. Frey stated that she thought the document would have the biggest impact on the administration and planning areas within NERL.

Dr. Demerjian added that the document also would serve to better focus the research. Dr. Reiter said that he would consider the document successful if it influenced how the research scientists plan their research. Ms. Garcia stated that she was unable to locate a good definition of exposure in the context of risk assessment and the risk paradigm; the framework document is a good starting point for addressing this gap. Dr. Demerjian suggested adding text to identify the roles of the other laboratories and centers in the paradigm. Dr. Hauchman indicated that he really liked the earlier discussion about creating an algorithm for prioritizing research; do the Subcommittee members think it is important to move to the next level of prioritization in the framework document or is that something that would better fit in a separate document? Dr. Frey said that the framework document, at the very least, should include a description of the prioritization process; further detail also could be included in the framework document. Dr. Bartell asked if NERL has quality assurance/quality control (QA/QC) procedures for evaluating its models. Dr. Weber responded that NERL employs a number of QA/QC methods, including sensitivity analyses. Referring to an earlier comment describing the framework as a living document, Dr. Bartell asked about the frequency of updating the document. Dr. Reiter said the schedule had not yet been determined.

## **WEDNESDAY, DECEMBER 12, 2007**

### **Re-Cap of Tuesday Discussions/Framework Discussion and Q&A**

*Dr. Kenneth L. Demerjian, Subcommittee Chair*

Dr. Demerjian said that he thought that the Subcommittee had a solid understanding of the audience for the document, what NERL hopes to achieve with the document, and the responsibilities of the various NERL divisions. He asked the other Subcommittee members if they had any additional questions or comments. Dr. Bartell asked for clarification on the charge question about new partnerships—is the Subcommittee being asked to suggest potential partners? He also asked how NERL planned to disseminate the final framework document. Dr. Reiter replied that partnership in that charge question referred to collaboration both within and outside of EPA, but especially to collaboration with organizations outside of EPA. Regarding dissemination, the framework document will probably be published in hard copy and posted on the NERL Web Site. Dr. Sheldon stated that she read the charge question as soliciting ideas from the Subcommittee regarding organizations with which NERL might work in the future. Dr. Sheldon proposed that the Subcommittee make suggestions as the members see fit; NERL then can determine if the partnerships are possible. Dr. Reiter said that there are many problems to address with limited resources, so NERL is always looking for ways to better leverage its work.

Dr. Frey asked about NERL's intellectual property policy. Dr. Reiter responded that if work is federally funded, anything produced through that work is the property of the Federal Government. Dr. Demerjian asked how costly work, such as measurement development, is funded. Dr. Reiter responded by providing an example. When EPA created its Computational Toxicology Research Program, an agreement was made within EPA that the Agency would not commit its resources to the sequencing of genomes; EPA's work instead would focus on the application of genomics. EPA approached the Joint Genome Institute, which is part of DOE, and asked if it would agree to sequence the genomes for a few species of interest to NERL. The Joint Genome Institute agreed to do this work. The institute was motivated to conduct the work because it would show that the information it produced was applicable to the broader community. Dr. Araujo added that the advantage of the OMB reviews is that many federal agencies are trying to be

more responsive to overall federal needs, encouraging collaboration with other agencies. Dr. Heggem gave another example. The National Aeronautics and Space Administration (NASA) gathers data using satellites, whereas NERL and other federal agencies analyze the data. NASA contacted the other agencies and allocated funds for their work. Dr. Araujo pointed out that this is more the exception to the rule; funding often is not attached to these requests. Dr. Bartell commented that it appeared that NERL already has extensive partnerships underway. What aspects of the framework does NERL see as being advantageous for accelerating or increasing these partnerships? Dr. Sheldon clarified that the charge question about partnerships is simply soliciting suggestions on potential future partnerships; the framework will not be used in developing those partnerships.

Dr. Bartell asked how the final framework document would be distributed within NERL. Dr. Reiter said that he envisioned the division directors presenting Dr. Sheldon's framework presentation to their employees, followed by a discussion of the implications of the document. Dr. Demerjian asked whether, in the planning process, a division will be expected to determine how core science fits into the problem-driven exposure framework. Dr. Reiter replied that he hoped that would occur. Dr. DePinto commended NERL on the framework document; NERL is not only communicating to its employees its purpose and future path, but it also is taking a leadership role in exposure science. There currently is much confusion about exposure science, and the framework document effectively communicates the definition of exposure science. He suggested that NERL may want to further clarify its definitions in the framework document. Dr. Reiter agreed with Dr. DePinto's assessment of the document, adding that he views the document as having much utility beyond NERL. Dr. Sheldon agreed and added that it is NERL's responsibility to effectively communicate the concepts in the framework. Dr. DePinto referred to the previous discussion of publishing the framework in the peer-reviewed literature. He envisioned the paper being somewhat different from the framework document itself, possibly providing examples not included in the framework document. In response to Dr. Weber's request for suggestions of journals to approach about publishing such a paper, Dr. DePinto suggested *Environmental Toxicology and Chemistry* or *Ecological Exposure Assessment and Management*. Dr. Demerjian suggested *Environmental Science & Technology* or the *Journal of the American Water Works Association*. Dr. Bartell added that he thought the framework could be used as a guide in developing an exposure science textbook.

### **Subcommittee Working Time**

#### *NERL Standing Subcommittee Members*

In response to questions regarding the homework sheets, Ms. Peterson clarified that they were only for the Subcommittee members' work time prior to the face-to-face meeting. Dr. Bartell asked if there was a deadline for submission of the homework sheets and reimbursement forms. Ms. Peterson said that there was no set deadline, but the sooner the forms are submitted, the sooner Subcommittee members will be reimbursed.

Dr. Demerjian asked the Subcommittee members for their thoughts on the framework. In his view, the framework effectively details NERL's future direction, but a better example than PM could be used to demonstrate the process. He asked the Subcommittee members if they had any suggestions on potential issues NERL might want to consider in terms of its future activities. Dr. Demerjian explained that the standing subcommittees are to meet at least once a year, each time to address a different set of issues for the laboratory or center. The topic to be addressed by the subcommittee could be as fundamental as a new emerging area, such as nanotechnology. Dr. Demerjian stated that Dr. Reiter seemed pleased that his laboratory now is more focused in its research. What are the next steps? Dr. Frey pointed out that Dr. Reiter is asking that the framework be applied to the research planning process, but it is not clear how the use or nonuse of the framework will be assessed. Some examples will need to be worked through before it can be determined if the framework is being used or not. Dr. DePinto suggested that when the framework document is distributed, it should be explained to the divisions that they are expected to use it in their planning process. The use or nonuse of the document then can be monitored and evaluated. Dr. Frey

agreed. Dr. Demerjian suggested that the divisions be asked to detail how their research plans fit within the framework; they could list the specific questions that will be answered by their research. A later presentation to the Subcommittee could report on the effectiveness of the process.

Dr. Frey thought that NERL already has benefited from the document, because the division directors are communicating more effectively. Drs. Bartell and Demerjian agreed. Dr. DePinto said that another measure of the value of the framework document is the extent to which it is used to obtain new staff expertise or redirect existing expertise to be more aligned with the exposure science. This is related to Charge Question 2, but actually exceeds that question, extending to the overall laboratory management and staffing process. Dr. Frey commented that she thought Section 4, the “how-to” section, was the weakest chapter in the document. Dr. DePinto said that the first three sections are important because they define the field of exposure science for the broader community. Dr. Frey agreed. Dr. DePinto suggested that Sections 1 to 3 be tightened up. The Subcommittee members discussed how the framework document should be designed to serve as a guideline for exposure science. Dr. DePinto proposed that the framework document include more detail and that the paper to be submitted for journal publication be more focused. Dr. Demerjian envisioned that the journal article would focus on EPA’s perspective on exposure science. Dr. Frey thought it was important that the community be educated on how EPA operates. She suggested the *Journal of the American Water Works Association* as a potential journal for publication because exposure is a key component in regulating drinking water standards. Dr. Frey further stated that she thought that the transition pathway, the process that occurs between data and exposure assessment, was not described in adequate detail in the document. There is a brief discussion of process science, but the text focuses more on how a source is delivered to the receptor and how the source is modified by the receptor to create an effect. The document needs better descriptions of process and delivery. In addition, the document ends at exposure, but there is no explanation of what that means. Dr. DePinto stated that the document describes exposure as contact between a stressor and a receptor, but exposure is not that simple. Exposure needs to be better defined to include the source pathway, from the transformation of the source in the environment to how the source interacts with the receptor. Dr. DePinto said this lack of complexity is evident in the discussion on mitigation in the document, as the focus is always on reducing exposure despite the fact that there are other ways to mitigate. Dr. Dockery thought the document was written from an air pollution health assessment perspective; he wondered if the framework would be as effective for an ecology issue. Dr. Frey stated that the document needed to be more clear and inclusive, especially Section 4, which is NERL’s business plan. The framework needs to explain in detail how NERL’s goals will be achieved. Dr. Demerjian asked the Subcommittee members whether each of their disciplines was represented in the document. Is there reason to believe that some exposures are multimedia? If so, are these considered in the document? It appears to him that the examples used are all driven by legislation and are not connected by a common thread. Dr. Dockery added that the document seemed to be written from the traditional single pollutant point-of-view, and real-world exposure issues are much more complex.

Dr. Frey suggested that more detail be added to the document addressing the effects of mitigation. Dr. Bartell argued that the document need not include that level of detail. Dr. DePinto agreed, explaining that he views mitigation as including the changes that may result from that mitigation.

Dr. Demerjian said that he was not sure if new ideas would fit under the framework. If not, that would be a problem because anticipatory research is an essential component of a research organization. Dr. DePinto agreed that this was an important issue and suggested addressing it in the report. Dr. Frey suggested that NERL develop a priority list for emerging issues; she did not see this addressed in the framework. Dr. Bartell said that, from the perspective of a PI, he would not be discouraged from addressing a new and innovative research question because the framework document clearly states the importance of both core and problem-driven research.

Dr. Demerjian asked the other Subcommittee members about the question in the framework document, “Is mitigation necessary?” Is it not necessary to know the outcome in order to mitigate? Dr. DePinto explained that the question is assuming that there are effects (this portion of the work is performed by NHEERL), but NERL ultimately determines how best to mitigate. Dr. Frey did not agree. NERL deals with the exposure assessment of the mitigation, not the actual mitigation. Dr. Bartell was under the impression from the framework document that the actual mitigation was performed outside of NERL. Dr. DePinto said that part of NERL’s job is to determine how best to mitigate; this question is best answered through collaboration. Drs. Bartell and Frey agreed. Dr. Demerjian said that, for air issues, NERL develops the models, and the Office of Air uses those models. Dr. DePinto stated that water is much more complicated. He views it as a continuum; on one end, it is obvious that mitigation is not necessary, and on the other, it is obvious that action must be taken. The exposure and effects assessments are needed between those two endpoints, at various levels of sophistication and complexity, depending on where the problem lies on the continuum. Dr. Frey asked how that would work at a national level. Dr. DePinto gave the example of solid waste disposal and management. EPA developed the 3MRA model, which represents how solid waste is treated at a number of different landfills across the country. The data are combined to determine if a specific solid waste needs to be controlled at the landfill level. Dr. Frey stated that mitigation is still technology and process model dependent. In this case, it seems that assumptions are being made about ground water infiltration and off-site migration rates. Dr. DePinto clarified that any assumptions made in the model are based on data. Dr. Demerjian commented that this discussion illustrated the importance of sharing the framework document with the other ORD laboratories and centers.

Dr. Frey suggested that the Subcommittee members circulate a copy of the framework document with comments and suggested edits displayed using the “track changes” feature. She proposed attaching this edited document to the Subcommittee’s report. After much discussion, the group decided against this suggestion as there would likely be many comments, and this would make the document difficult to read. Instead, Dr. Demerjian suggested that each Subcommittee member list any comments or questions about the framework document in his/her draft response. The framework document will be revised a number of times, so the final document likely will be significantly different from the current draft.

Dr. Bartell thought some of the figures in the document could be redrawn to be more effective, especially the comparison between human health and ecology, which includes a number of errors. He asked where these types of comments should be included. Dr. DePinto noted that some of the comments he had heard belong in the response to Charge Question 1, which focuses on improving the effectiveness of the document. If the effectiveness of the document can be improved by changing a figure, then that should be included in the response to Charge Question 1. Dr. Demerjian asked the Subcommittee members to organize their comments accordingly. He suggested that the report include a section addressing the charge questions and a section for specific detailed comments about the framework document.

Dr. DePinto stated that he was not clear on how to address Charge Question 2, which asks about the core areas of expertise needed in NERL. Should the Subcommittee members review the biosketches for NERL staff? Dr. Frey pointed out a chart that categorized the NERL staff by expertise. According to the chart, most of the expertise is in the physical and biological sciences, but expertise is low in the areas of modeling, statistics, and the social sciences. Dr. Bartell cautioned that the chart most likely does not tell the whole story. Dr. Demerjian agreed, stating that those listed as physical scientists could perform modeling work in their day-to-day activities. He added that the core areas of expertise are in the process sciences associated with the media, such as fate and transport. Dr. Demerjian did not think it was necessary for the Subcommittee members to read all of the biosketches; the Subcommittee can refer to the figure in the document, which shows a reasonable distribution of expertise. Another related issue mentioned by Dr. Demerjian, is that the Subcommittee is being asked to answer the question based on a hypothetical framework that has not been demonstrated through the use of examples. It would be helpful to have some concrete examples.

Dr. Frey said that NERL views its end product as the development of models to quantify exposure. Dr. Demerjian sees NERL as having two clients, one of which is NHEERL. Whereas NERL and NHEERL work together, it seems that NERL could do more to better inform NHEERL's work. Dr. Frey agreed and pointed out that the document does not explicitly list NERL's customers.

Dr. Demerjian asked the Subcommittee members whether they had any issues with the charge question assignments or any specific issues that they would like to raise to the other Subcommittee members. Dr. Frey asked the other Subcommittee members for their views on publishing the framework document. Dr. DePinto said that he liked Dr. Bartell's suggestion to convert the document into an Agency-sanctioned guidance document and proceed from there. Doing so would allow for future expansion. Dr. Bartell thought the framework document could serve as a guideline for all exposure science research, and Dr. Demerjian agreed. Dr. Demerjian added that after the guidance document is finalized, it then could be used as the basis for a journal article.

Dr. Demerjian suggested that the Subcommittee request a description of an MYP planning process using the framework document. This information will help the Subcommittee determine whether the framework document is useful in the actual planning process and will highlight areas that need to be strengthened.

Dr. DePinto asked if NERL planned to revise the framework document based on the Subcommittee's feedback. Dr. Demerjian replied that he did not know; he viewed this round of review as focusing more on general feedback, which probably will prompt some changes to the document. The Subcommittee then will review the revised document. If this is the case, NERL should include new examples in the updated document. Alternatively, NERL may ask the Subcommittee to address a completely different topic.

Dr. Dockery asked the other Subcommittee members for a general assessment of the framework document. Dr. Bartell thought the document did a good job of defining exposure but was weaker in terms of operationalizing the concepts. Dr. Demerjian said that there are two major questions: (1) If the intent of the document is to focus the work of the different divisions, has this been accomplished? (2) Is the document properly constructed to support NERL's future planning? Dr. Demerjian thought the document focused more on air and human health issues than on other issues. Dr. Bartell said that from the ecosystems perspective, he thought the document was strong. Dr. DePinto stated that he would like to see more balance in the examples used and suggested adding aquatic ecosystems. Dr. Demerjian proposed that NERL choose one air example and one ecology example.

### **Future Discussion/Future Business**

*Dr. Kenneth L. Demerjian, Subcommittee Chair*

Dr. Demerjian asked the Subcommittee members to send their draft responses to him by the end of the following week (by December 21, 2007). He will compile the documents and distribute the draft to the Subcommittee. A follow-up conference call will be scheduled to discuss the draft. The Subcommittee members' first priority is to answer the charge questions. The second priority is to offer more general comments or suggestions.

Dr. Demerjian asked Ms. Peterson if she could send him a previous standing committee report to use as an example; she said that she would. Dr. Demerjian asked the Subcommittee members to send Ms. Peterson a list of dates they are available for a conference call in mid-January.



### **Preliminary Feedback**

*Dr. Kenneth L. Demerjian, Subcommittee Chair*

Dr. Demerjian explained that the Subcommittee would aim to produce a draft report by mid-January. The Subcommittee's report will focus on answering the charge questions. In addition, the Subcommittee members have been asked to offer any general comments or suggestions that they think will further strengthen the document. He said that the Subcommittee members would be available for a follow-up conference call if, after reviewing the document, the NERL leadership has any questions or comments.

The general consensus of the Subcommittee is that the framework is a useful document, especially for NERL. There is some concern about how the other ORD laboratories and centers may view the document; therefore, the Subcommittee recommends that the document be vetted by the other laboratories and centers before it is finalized.

The framework document could be strengthened through the addition of a detailed description of the document's target audience. The Subcommittee also recommends that the document be developed as a guidance document. From this guidance document, a short paper then could be drafted for submission to a journal. The Subcommittee recommends identifying and working through one air example and one ecology example to truly assess the utility of the document. Another area that needs further clarification is the water quality research to be performed. For example, what part of the work will be performed by NERL and what part by NHEERL?

Dr. DePinto suggested that the framework be used in the research planning process and a post-audit be performed to assess the effectiveness of the document. This will highlight the areas of the framework that need to be strengthened.

Dr. Reiter asked the Subcommittee members if they thought that anything was missed in sections 1 to 3. Dr. DePinto replied that he thought the sections were very good, but they may be too air- and health-centric in terms of the examples provided. Additional examples could be added to better balance the document. He also suggested that more emphasis be placed on the processing of sources.

Dr. Demerjian asked if there were any more questions. Hearing none, he thanked everyone for their participation and adjourned the meeting at 12:03 p.m.

### **Action Items**

- ✍ The Subcommittee members will send their homework sheets and reimbursement forms to Ms. Peterson.
- ✍ Ms. Peterson will send Dr. Demerjian a sample standing subcommittee report.
- ✍ The Subcommittee members will send their draft responses to Dr. Demerjian by Friday, December 21, 2007.
- ✍ Dr. Demerjian will compile the drafts in one document and distribute it to the Subcommittee members.
- ✍ The Subcommittee members will send Ms. Peterson a list of dates they are available for a mid-January conference call.

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**NATIONAL EXPOSURE RESEARCH LABORATORY STANDING SUBCOMMITTEE  
FACE-TO-FACE MEETING AGENDA**

**December 11-12, 2007**

EPA Facility

109 TW Alexander Drive

National Computing Center, Room N110

Research Triangle Park, NC 27711

**Tuesday, December 11th**

8:00 a.m. – 8:30 a.m.	Registration	
8:30 a.m. – 9:00 a.m.	Welcome and Opening Remarks - Introductions - Overview of Agenda	Dr. Kenneth L. Demerjian Subcommittee Chair
9:00 a.m. – 9:05 a.m.	BOSC DFO Remarks - Administrative Issues	Ms. Susan Peterson Office of Research and Development
9:05 a.m. – 9:45 a.m.	NERL Organization - Discussion and Q&A	Dr. Larry Reiter Director, NERL
9:45 a.m. – 10:45 a.m.	NERL Research Program - Discussion and Q&A	Dr. Rochelle Araujo Subcommittee/NERL
10:45 a.m. – 11:00 a.m.	Break	
11:00 a.m. – 12:30 p.m.	Exposure Science Framework  - Discussion and Q&A	Ms. Linda Sheldon Associate Director for Health/NERL  Subcommittee/NERL
12:30 p.m. – 1:30 p.m.	Lunch	
1:30 p.m. – 3:00 p.m.	Framework Implications for NERL  - Discussion and Q&A	Ms. Linda Sheldon Associate Director for Health/NERL  Subcommittee/NERL
3:00 p.m. – 3:15 p.m.	Public Comment	



3:15 p.m. – 3:30 p.m.	Break	
3:30 p.m. – 4:00 p.m.	Subcommittee Follow-Up Questions	Dr. Kenneth L. Demerjian Subcommittee Chair
4:00 p.m. – 5:00 p.m.	Subcommittee Working Time	Subcommittee Members

**Wednesday, December 12th**

8:30 a.m. – 8:45 a.m.	Re-cap of Tuesday Discussions	Dr. Kenneth L. Demerjian Subcommittee Chair
8:45 a.m. – 9:30 a.m.	Framework Discussion and Q&A	Dr. Kenneth L. Demerjian Subcommittee Chair
9:30 a.m. – 11:30 a.m.	Subcommittee Working Time	Subcommittee Members
11:30 a.m. – 12:00 p.m.	Preliminary Feedback	Dr. Kenneth L. Demerjian Subcommittee Chair
12:00 p.m. – 12:15 p.m.	Future Discussion/Future Business - Discuss Writing Assignments - Identify Additional Needs	Dr. Kenneth L. Demerjian Subcommittee Chair
12:15 p.m.	Adjourn	